

[54] **ROADWAY PAINT STRIPE GROOVING MACHINE**

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[51] Int. Cl. **E01c 23/09**

[58] Field of Search **299/37-41; 37/190; 173/24; 61/63**

[56] **References Cited**

UNITED STATES PATENTS

3,407,005	10/1968	Simms et al.	173/24 X
3,298,117	1/1967	Pelzer et al.	37/190

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[57] **ABSTRACT**

A machine for cutting grooves and intervening ridges in a roadway to receive a reflective paint and function as lane dividers. A self-propelled vehicle has a power transmission for rotating a cutter to cut the grooves to a predetermined depth as the vehicle moves along the roadway at a relatively slow speed, the cuttings being flushed from the roadway surface by water which cools and cleans the cutter, vacuum apparatus sucking the water and cuttings from the roadway surface to a separator tank for separation of the air and slurry, a slurry pump transferring the slurry to a tank for separation of the cuttings from the water. A prime mover and power transmission separate from the normal vehicle power train can drive the vehicle at a relatively slow but variable speed during the cutting operation, and at a faster speed when the vehicle motion is reversed with the cutter disengaged from the roadway surface or the cutter is otherwise disengaged. The separate prime mover and transmission are ineffective with the cutter elevated from the roadway surface when the normal vehicle power train is operative to permit highway travel of the vehicle at normal traffic speeds.

22 Claims, 11 Drawing Figures

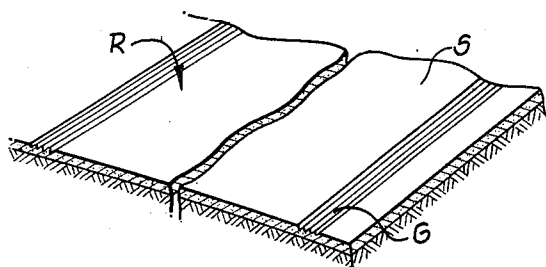


FIG. 2.

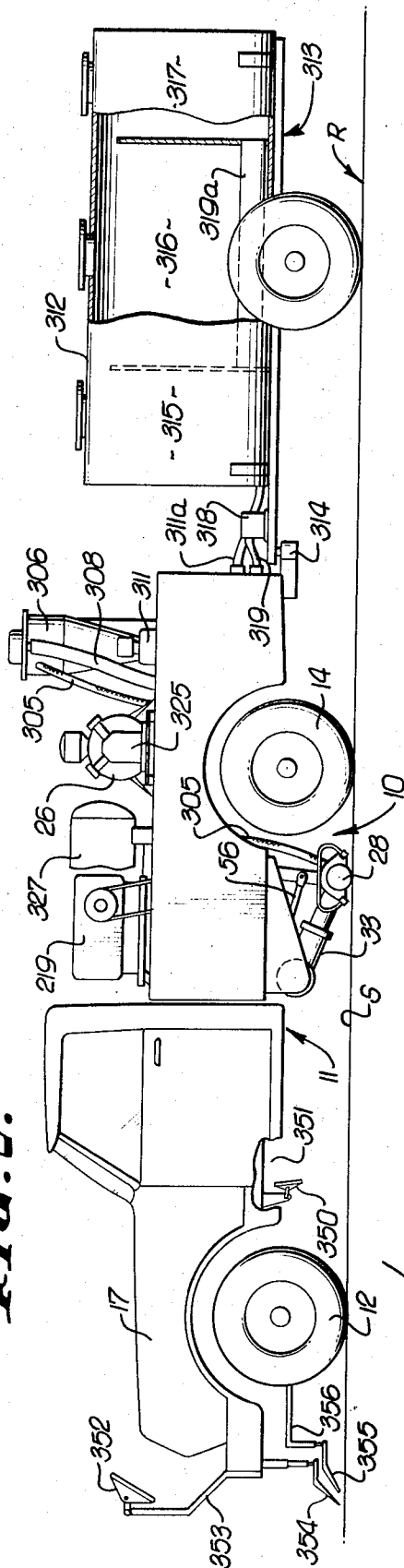


FIG. 1.

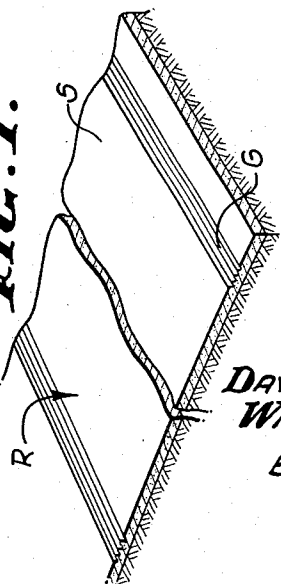
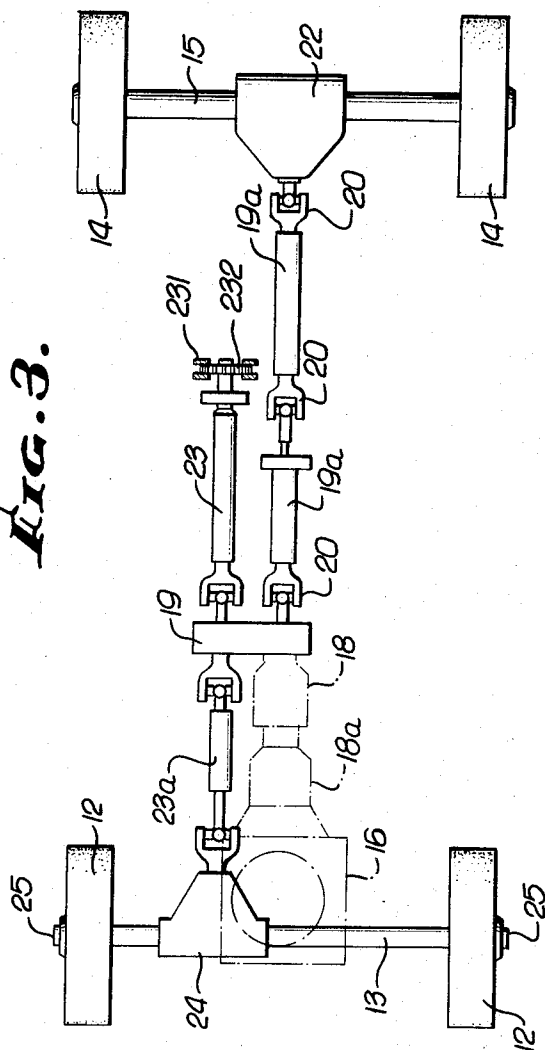


FIG. 3.



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FIG. 4.

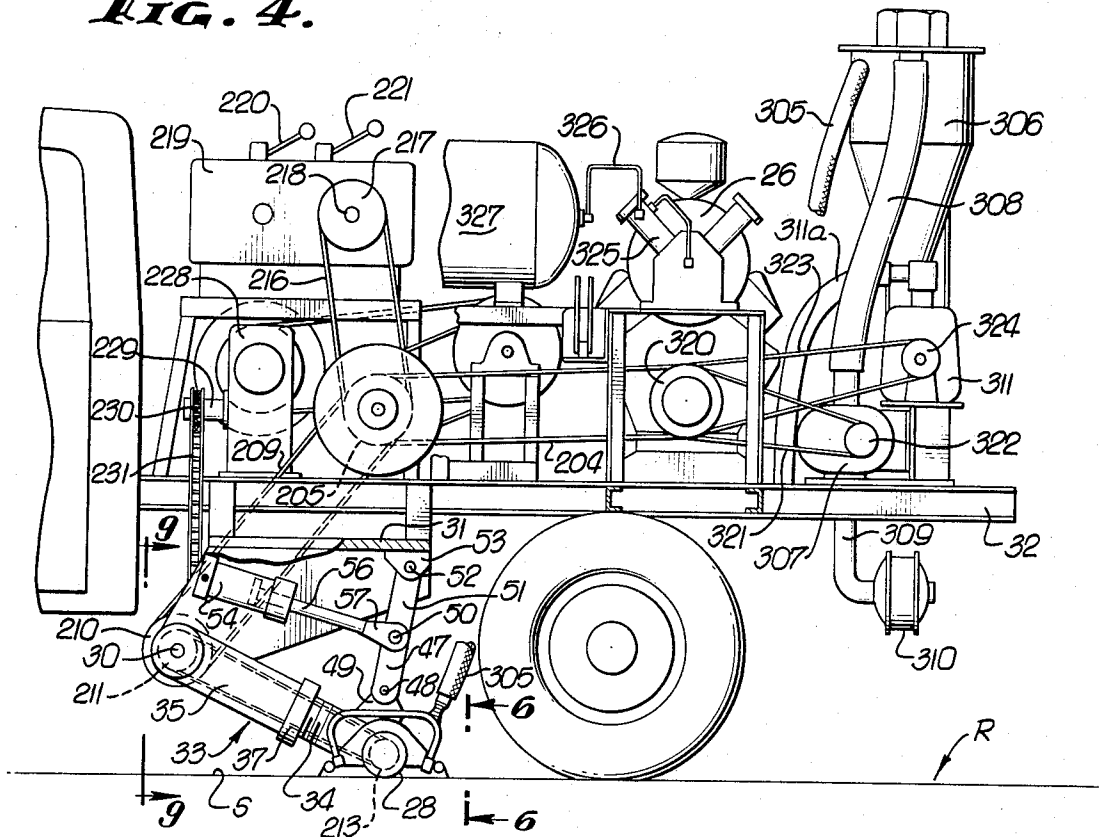
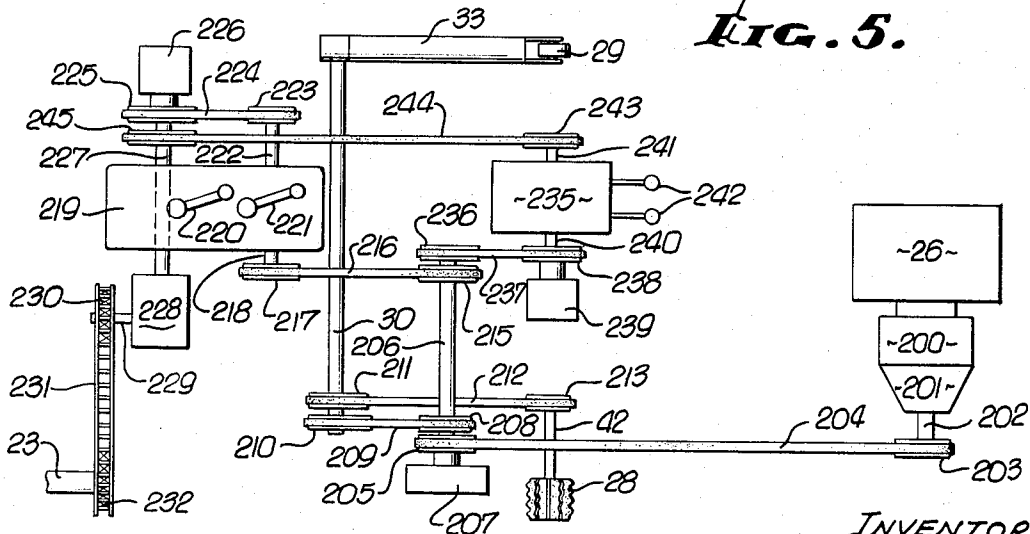
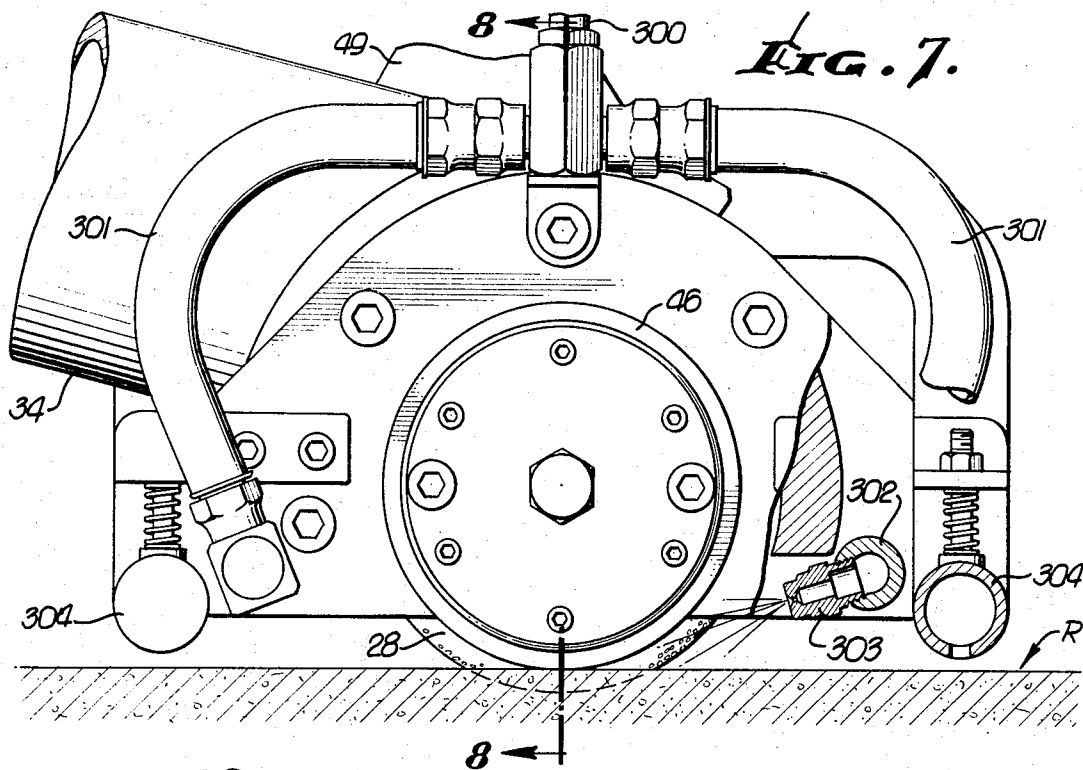
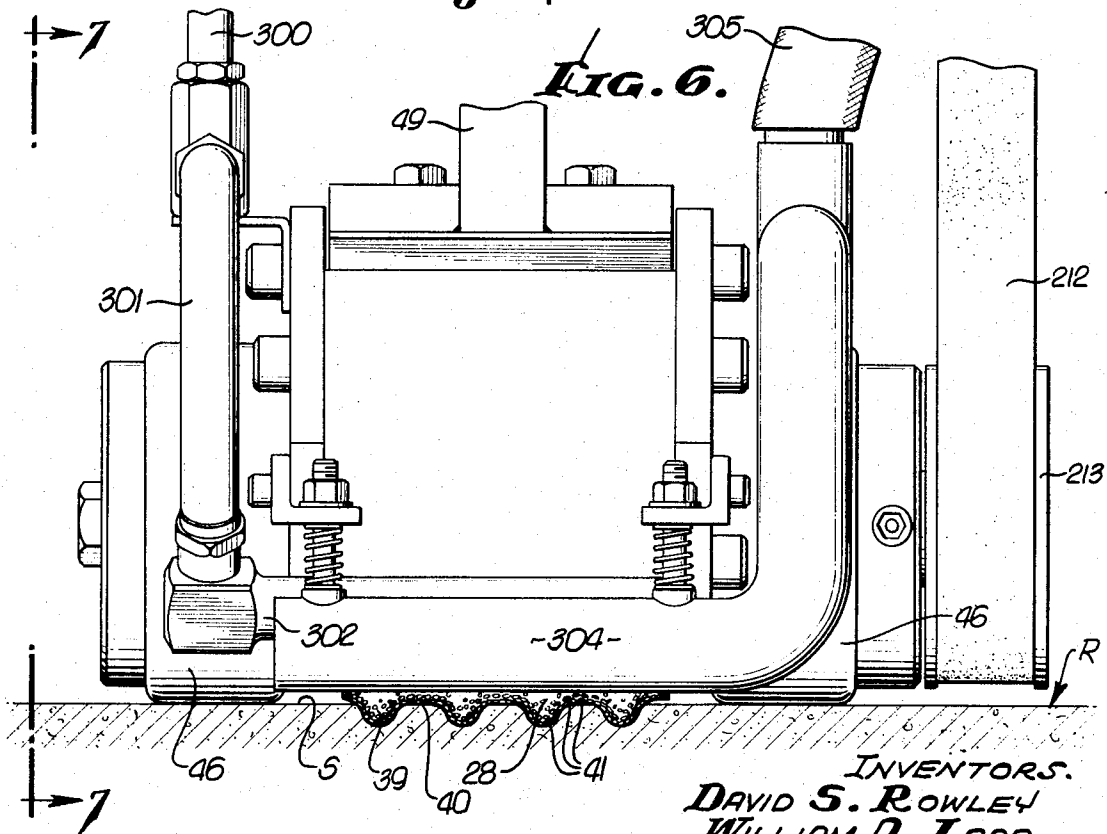


FIG. 5.



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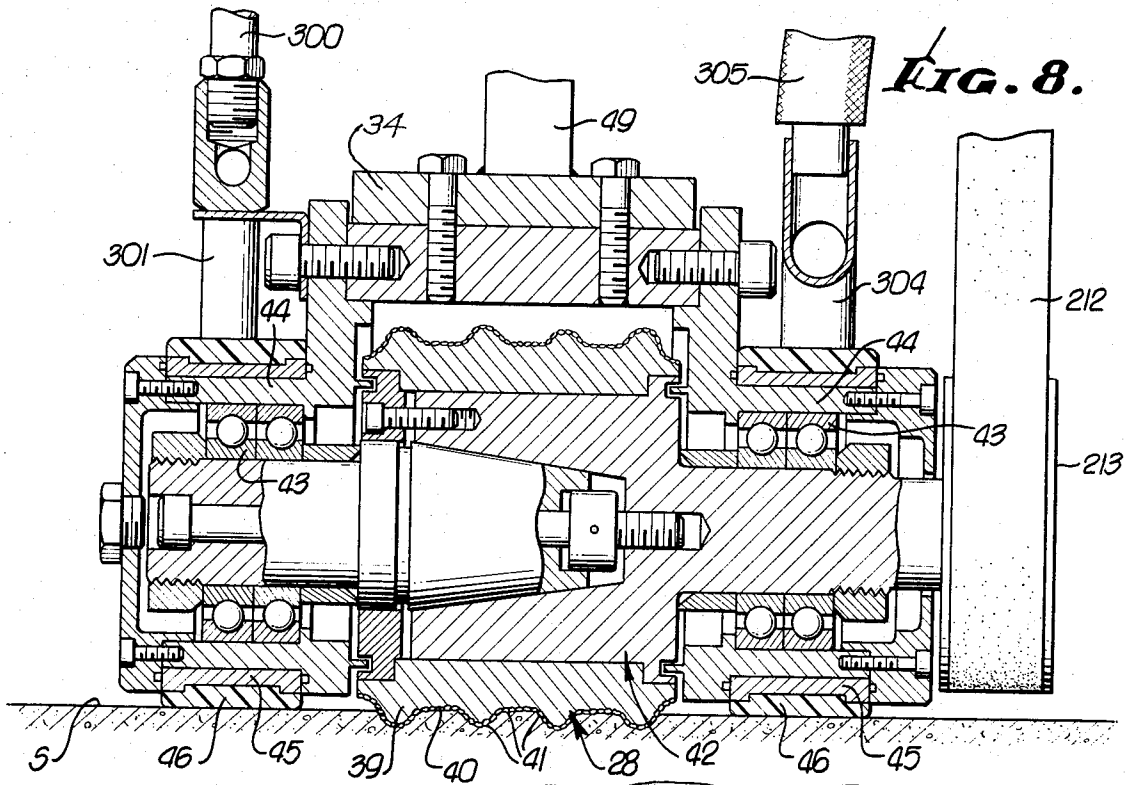
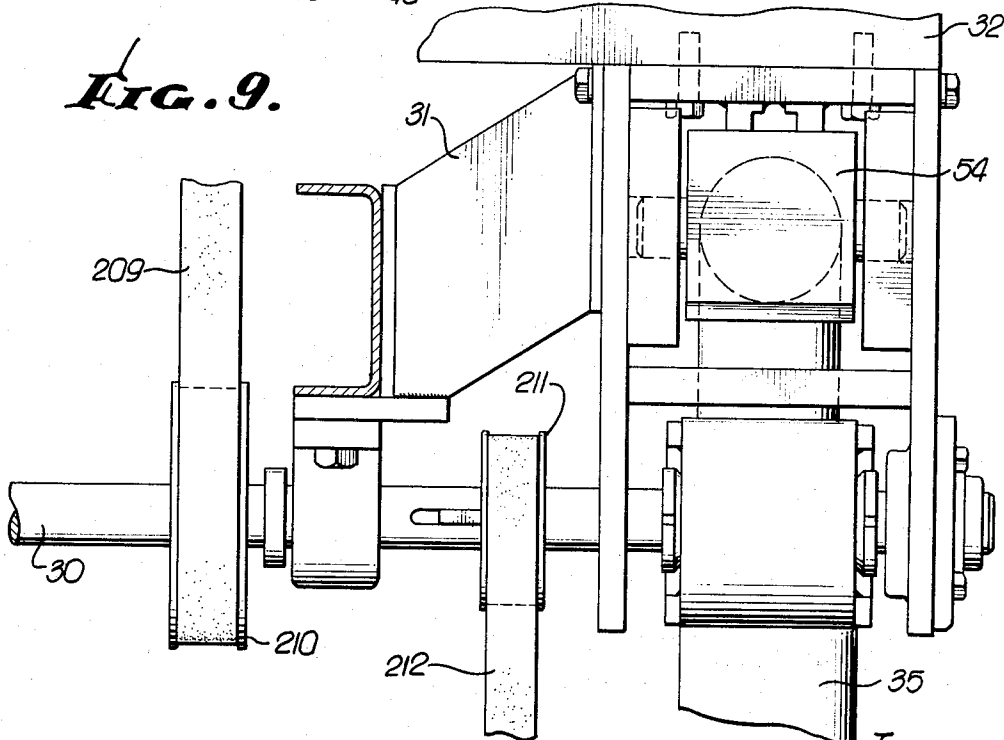


Fig. 9.



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ROADWAY PAINT STRIPE GROOVING MACHINE

The present invention relates to the grooving of roadway surfaces, and more particularly to a machine for cutting parallel grooves separated by parallel ridges at the lane divider locations of the roadway, the grooves and ridges preferably to receive reflective highway paint.

As shown and described in the U.S. Pat. No. 3,529,517 of Gordon M. Liddle and Frank L. Christensen, for "Marked Roadway and Method of Making the Same", a roadway of a hard material, such as concrete, has parallel grooves or valleys cut into a roadway surface to form intervening parallel ridges, the valleys and ridges being coated with reflective highway paint, thereby resulting in the provision of a marking or stripe defining the side boundary of a traffic lane.

In the application of Donald H. Mabey and Jack C. Gledhill, filed Jan. 22, 1969, Ser. No. 793,054, for "Cutters for Forming Highway Paint Receiving Grooves", now United States Patent 3,554,606 a rotatable cutter is illustrated and described for forming the valleys and grooves shown in U.S. Pat. No. 3,529,517. As an example, the cutter is effective to operate on the roadway surface over a width of about 4 inches. The valleys or grooves produced by the cutter in the highway or roadway surface have tapered side walls diverging in an upward and outward direction, enabling the painted sides of the grooves to be visible to the occupants of vehicles traversing the roadway.

Machines are known for cutting grooves in concrete and other roadway surfaces. However, they cannot cut grooves having upwardly divergent side walls since they usually employ a multiplicity of rotatable saw blades for performing the cutting operation. A machine that forms divergent sides in the grooves which it produces is illustrated in U.S. pat. No. 3,414,327. This machine is operative for performing a planing operation on a roadway surface, the width of cut being of the order of about three feet. Such machine is comparatively complex and costly and is capable of operating at only a slow speed. It is not capable of self-transport from one job location to another over a normal highway surface because of its comparatively low maximum speed.

By virtue of the present invention, a machine is provided that can accomplish the roadway grooving at controlled, yet variable speeds of the vehicle which, for example, may range from about five to twenty feet per minute. Yet the apparatus is still capable of over-the-highway use at normal traffic speeds which, for example, may range from about 30 to 70 miles per hour.

The rotatable cutter for performing the grooving operation can be raised and lowered from and into contact with the pavement, the depth of the cutter penetration below the pavement surface being precisely controllable.

The lateral position of the cutter on the roadway can be controlled during grooving, as by means of an automotive type steering mechanism, the operator of the vehicle or machine being capable of steering the machine in such manner as to cause the cutter to proceed along a desired path or line of grooving.

Through use of the machine embodying the present invention, detritus and liquids can be vacuumed from the grooved area while the grooving operation is being performed, thereby preventing the cuttings from packing into the grooves produced.

Detritus and liquids vacuumed from the groove area while the grooving operation proceeds are pumped to a tank for disposal and separation of the water in the sludge from the cuttings, the water then being reusable for flushing the grooved area while grooving proceeds.

Through use of the equipment, a substantial reduction in labor cost is achieved, since a single operator can control the cutting operation while the machine moves over the roadway surface, pulling a tank trailer which carries a vacuum source, sludge tank, and water supply for flushing the grooved area. All of such equipment can be transported from job to job at normal traffic speeds, avoiding the necessity for extra equipment, such as a tilt bed tractor-trailer, for transporting a cutting machine for performing grooving of the roadway surfaces, and for self-propelled water tankers, and the like, which require their own operator.

This invention possesses many other advantages, and has other purposes which may be made more clearly apparent from a consideration of a form in which it may be embodied. This form is shown in the drawings accompanying and forming part of the present specification. It will now be described in detail, for the purpose of illustrating the general principles of the invention; but it is to be understood that such detailed description is not to be taken in a limiting sense.

Referring to the drawings:

FIG. 1 is an isometric view of a roadway with grooves cut therein that function as highway lane dividers;

FIG. 2 is a diagrammatic side elevational view of a machine for cutting grooves in a roadway, and including a self-propelled vehicle and a trailer attached thereto;

FIG. 3 is a top plan view of a portion of the four wheel drive mechanism for moving the vehicle along the roadway;

FIG. 4 is a side elevational view of the power and cutter mechanism mounted on the vehicle for cutting the grooves in the roadway;

FIG. 5 is a diagrammatic view of the several power transmission trains for rotating the cutter and for moving the vehicle along the roadway at variable speeds;

FIG. 6 is an enlarged section taken along the line 6—6 on FIG. 4;

FIG. 7 is an enlarged view taken along the line 7—7 on FIG. 6;

FIG. 8 is a vertical section taken along the line 8—8 on FIG. 7;

FIG. 9 is an enlarged view taken along the line 9—9 on FIG. 4;

FIG. 10 is an enlarged side elevational view of the supporting mechanism for an equalizing wheel that engages the roadway surface, for the purpose of counteracting the thrust of the rotatable grooving cutter;

FIG. 11 is an enlarged fragmentary section taken in the region indicated by the number 11 on FIG. 10.

An apparatus 10 for cutting grooves G in a roadway surface S is illustrated in the drawings, the apparatus being mounted on an over-the-road vehicle 11 having steerable front wheels 12 associated with a front axle 13, and rear wheels 14 associated with a rear axle 15. The vehicle has a four wheel drive, of a known type, power being received from an engine 16 mounted under the hood 17, which drives through a clutch 18a and change speed transmission 18 into a transfer case 19, from which rotary motion and torque is transmitta-

ble through a sectional drive shaft 19a and intervening universal joints 20 to a differential 22, through which the power is distributed to the rear wheel 14.

An idler gear (not shown) in the transfer case 19 normally interposed between the rear wheel drive shaft 19a and a front wheel drive shaft 23a has been removed, so that during normal over-the-road highway operation of the vehicle 11, the drive shaft 23 does not rotate and power is not transmitted through the front differential 24 and axle 13 to the front wheels 12, the front wheels being in a free wheeling condition. Each front wheel 12 is releasably coupled to the front wheel drive by a known type of axle clutch 25 (not shown in detail) which is engaged when the front wheels 12 are to be driven, and which is disengaged when the front wheels are to be placed in a free wheeling condition. Details of the front wheel and axle clutches 25 are not illustrated since they are devices obtainable from known sources in the open market. As an example, axle clutches can be used manufactured by Warn Industries, Inc. and known as a Warn Hub.

The axle clutches 25 are engaged when the apparatus is conditioned for grooving the roadway, at which time the main truck engine 16 is idle, with the change speed transmission 18 placed in a neutral condition. With the axle clutches 25 engaged, power is delivered from a separate engine 26 mounted on the truck 11 to the grooving drive shaft 23, which is directly connected through the transfer case 19 to the front axle drive line 23a, 24. Power from the engine 26 is also delivered, as described hereinbelow, to a rotatable diamond cutter 28, which will effect the grooving of the roadway R as the vehicle is moved through its front wheel drive therealong.

The rotatable cutter 28 is supported at one side of the vehicle 11 and an equalizing wheel or roller 29 (FIGS. 5, 10) is supported at the other side of the vehicle to counteract the cutter thrust, which might tend to tip the vehicle. As disclosed, a jack shaft 30 is suitably supported in a frame 31 secured to and disposed below the usual truck chassis 32. An adjustable arm 33 is pivotally mounted on the jack shaft 30 at one side of the vehicle, the effective length of the arm being adjustable by shifting its outer portion 34 within its inner portion 35, the extent of inward movement of the outer portion being limited by a stop collar 36 (FIG. 11) threaded on the outer portion abutting the end of the inner portion. Outward movement of the outer portion 34 relative to the inner portion 35 is prevented by a clamp nut 37 threaded on the outer portion and having a flange 38 that engages the stop collar 36.

The cutter 28 which has spaced parallel ridges 39 thereon normal to its axis and intervening valleys or grooves 40, the ridges and grooves having diamond cutting elements 41 thereon, is described in the above-identified application, Ser. No. 793,054. It is suitably secured to a shaft structure 42 (FIG. 8) supported in bearings 43 mounted within bearing supports 44 suitably secured to the outer arm portion 34. For the purpose of limiting the depth of penetration of the cutter into the roadway surface S, control rollers 45 are rotatably mounted on the bearing supports 44 on opposite sides of the cutter, these rollers having rims 46 made of a suitable material, such as polyurethane. These rims engage the roadway surface, limiting the ex-

tent that the larger diameter ridges 39 of the cutter can penetrate into the roadway surface. As specifically illustrated, the diameter of the depth-of-cut roller rims 46 is equal to the diameter of the inner bases of the grooves or valleys 40 of the cutter.

The rotatable cutter 28 is lowered into a cutting position for penetrating the pavement surface, and can be elevated therefrom, by a fluid operated cylinder and linkage mechanism. Another like mechanism is used for raising and lowering the equalizing roller 29 (FIG. 10). As specifically shown, a lower link 47 is pivotally connected by a pin 48 to an arm 49 secured to and extending upwardly from the outer portion 34 of the supporting arm 33. The upper end of this link has a pin 50 extending therethrough which also extends through the lower end of an upper link 51, the upper end of which is connected by a pivot pin 52 to a bracket 53 secured to the frame 31. A cylinder 54 has its head end suitably, pivotally connected to the frame 31, a piston 55 being reciprocable in the cylinder and having a rod 56 extending from the rod end of the cylinder and attached to a yoke 57 connected to the intervening pin 50.

When air under pressure is introduced into the head end of the cylinder 54, it shifts the piston 55 and rod 56 outwardly, which will act on the linkage 47, 51 to swing the cutter supporting arm 33 downwardly about the axis of the jack shaft 30 and bring the rotating cutter 28 into engagement with the roadway surface S, the extent of its penetration into the roadway being limited by engagement of the depth-of-cut rollers 45 with the roadway surface. When the cutter is to be elevated, air under pressure is fed into the rod end of the cylinder 54, effecting retraction of the piston 55 and rod 56 therewithin, swinging of the upper link 51 about its upper pivot 52 to effect an upward movement of the lower link 47 and of the lower portion of the supporting arm 33 and of the cutter 28, to remove the latter, as well as the depth-of-cut rollers 45 from the roadway surface S.

A similar arrangement is disposed on the other side of the vehicle (FIG. 10). Thus, an adjustable arm 33 is pivotally mounted on the jack shaft 30, a cylinder 54, piston 55, rod 56 and linkage mechanism 47-53 being pin connected to each other and to the frame 31, as well as to the outer end of the adjustable arm 34, this arm rotatably carrying the equalizing wheel 29, which will engage the roadway surface S. The equalizing wheel is engaged with the roadway surface simultaneously with downward movement of the cutter 28 into engagement with the roadway surface, and it is elevated from the roadway surface simultaneously with elevation of the cutter therefrom.

The cutter 28 is rotated, and the vehicle driven through its front wheels 12, by the prime mover 26 mounted on the chassis 32 of the vehicle, and which is separate from the normal engine 16 used for moving the vehicle over the road. The rotation of the engine 26 is transmitted through a releasable clutch 200, such as an air operated clutch, to a gear reducer 201, the output shaft 202 of which has a sheave 203 affixed thereto. A belt 204 passes over this sheave and over a driving sheave or pulley 205 rotatably mounted on a shaft 206 suitably supported on the vehicle frame 32, a suitable clutch 207, such as an air operated clutch, being engageable to transmit the torque and turning effort from

the driven pulley 205 to the shaft 206. Another pulley 208 is affixed to the shaft 206, driving a belt 209 which, in turn, drives a pulley or sheave 210 affixed to the jack shaft 30. Rotation of the jack shaft is transferred to the cutter 28 through a driving pulley or sheave 211 mounted on the jack shaft 30, around which a belt 212 passes, which also passes around a pulley 213 affixed to the cutter shaft structure 42.

It is apparent that when the main engine clutch 200 is engaged and the other clutch 207 is also engaged, rotation of the cutter 28 is effected. Disengagement of the clutch 207 will, of course, effect discontinuance in the rotation of the cutter.

While the cutter 28 is being rotated, the vehicle may be driven through its front wheels 12 from the same engine power source 26 as operates the cutter, the normal vehicle engine 16 being inoperative to transmit motion to the rear wheels 14 of the vehicle. Secured to the shaft 206 is a driving pulley 215 over which a belt 216 passes, which also passes over a driven pulley 217 secured to the drive shaft 218 of a low speed variable transmission ratio gear reducer 219, the transmission ratio being selected by the operator through appropriate manipulation of the gear shift handles 220, 221. The output or driven shaft 222 of the transmission 219 has a pulley 223 affixed thereto which drives a belt 224 passing over another pulley 225 attached to the driving member of an air operated clutch 226, the driven portion of this clutch being secured to a shaft 227 which is rotated when the air clutch is engaged. This shaft 227 forms the input or drive shaft of a right angle gear reducer box 228 that effects rotation of its driven shaft 229 that has a sprocket 230 affixed thereto over which a drive chain 231 passes and which meshes with a driven sprocket 232 affixed to the drive shaft 23 that effects rotation of the front wheels 12, when the axle clutches 25 are engaged, and propulsion of the vehicle over the roadway R (FIGS. 5, 3).

It will be apparent that the engagement of the low speed air clutch 226 will effect forward propulsion of the vehicle at a speed dependent upon the gear ratio selected through manipulation of the shiftable handles 220, 221. The vehicle is also movable forwardly at relatively high speeds with the cutter 28 disengaged from the pavement R, but still rotating since the air clutch 207 is held engaged, although the other air clutch 226 leading to the gear reducer box 228 is disengaged. The rotation of the shaft 206 is transmitted to a high speed forward and reverse gear box 235 through a pulley 236 affixed to the shaft 206, around which a belt 237 passes. It also passes around a driven pulley 238 affixed to the driving portion of another clutch 239, such as an air clutch, the driven pulley 238 being rotatably mounted on a transverse shaft 240. When the clutch 239 is engaged, the shaft 240 is rotated, the rotation of this shaft, which is a relatively high speed shaft, being transmitted through the gear box 235 to an output shaft 241. The shift levers 242 of the gear box can be manipulated to provide several forward speeds of the output shaft 241, as well as rotation of the output shaft in a reverse direction, all of such speeds being higher than any of the low speed transmission ratios than can be selected in the gear box 219 for normally propelling the vehicle in the forward direction with the cutter 28 engaging the pavement. The rotation of the driven shaft

241 in either forward or reverse direction, as selected by the shift levers 242 of the high speed forward and reverse gear box 235, is transmitted from a drive pulley or sheave 243 fixed to the driven shaft 241 to a belt 244 which, in turn, passes over a driven pulley or sheave 245 affixed to the shaft 227 that rotates the front wheels 12 through the gear box 228 and sprocket and chain train 230-232. Accordingly, motion of the vehicle with the cutter 28 disengaged from the pavement is secured at a substantially higher forward speed than the vehicle is moved with the cutter engaged with the pavement. Reverse movement of the vehicle with the cutter 28 disengaged from the pavement can be obtained through disengagement of the air clutch 226 and engagement of the other clutch 239. Preferably, the apparatus is equipped with automatically actuated interlocking devices that prevent the possibility of simultaneous engagement of both clutches 226, 239.

Water for cooling the cutter 28 and for cleaning the pavement surface S of cuttings is directed into a water line 300, the entrance to which may be conveniently located at the rear of the vehicle, which communicates with a pair of oppositely directed branching water lines 301 that feed water into a pair of headers 302 disposed forwardly and rearwardly of the cutter 28, and having nozzles 303 therein for directing water jets against the cutter and the pavement surface (FIGS. 7, 8). The slurry of water and cuttings, and ambient air, are removed from the working region by a vacuum pick-up device including vacuum tubes 304 disposed forwardly and rearwardly of the cutter and of the nozzles, these vacuum tubes being connected to a suction line 305 extending to the upper end of a cyclone separating tank 306 (FIG. 4). The vacuum is produced by a positive displacement vacuum pump 307 mounted on the vehicle, there being a suction pipe 308 extending from the upper end of the separating tank to the vacuum pump and a discharge pipe 309 running from the vacuum pump and through a suitable muffler 310 to the atmosphere.

The water and cuttings settle toward the bottom of the separating tank 306 and are removed therefrom by slurry pump 311 connected thereto, which pumps the slurry through a discharge hose 311a which is connected to the bottom of a slurry tank 312 mounted on a trailer 313 suitably coupled to the rear end of the truck chassis, as by means of a coupling hitch 314. The tank is divided into a plurality of compartments 315, 316, 317, such as three separate compartments, the center tank 316 being the one into which the slurry is discharged from the line 311a, the cuttings settling to the bottom of this tank; whereas the clean water is carried in the end compartments 315, 317, a pump 318 on the trailer pumping this water through a line 319 connected to the fresh water inlet 300. The end compartments intercommunicate through a pipe 319a extending through the lower portion of the center tank 316.

The vacuum pump 307 is driven from the grooving engine 26, there being a driving pulley 320 secured to the engine shaft which transmits its motion through a belt 321 to a pulley 322 mounted on an operating shaft of the vacuum pump. Similarly, the slurry pump 311 is driven from the engine 26, there being a driving pulley (not shown) mounted on the engine shaft which transmits its motion through a belt 323 to a driven pulley

324 fixed to the shaft of the slurry pump. As disclosed in the drawings, an air compressor 325 is also carried on the truck, being suitably power operated from the engine 26. The compressed air passes through a suitable line 326 to an air storage tank 327 supported on the vehicle.

In the operation of the apparatus in performing a grooving operation in the pavement surface, the vehicle clutch 18a is disengaged, the axle clutches 25 being engaged so that the propulsion of the vehicle takes place through the front wheels 12. The engine 26 is started and the clutch 200 engaged with the cutter 28 and equalizing wheel or roller 29 out of engagement from the pavement surface, thereby effecting rotation of the cutter through the power train 203-213. Air under pressure is now fed into the head ends of the cylinders 54 which will engage the rotating cutter 28 and the equalizer wheel 29 with the pavement surface S, the proper gear ratio being selected in the gear box 219, and the air clutch 226 engaged to effect forward propulsion movement of the vehicle with the cutter 28 cutting the grooves G in the roadway surface along a desired path. The appropriate positioning of the cutter is noted by the operator of the vehicle through an inclined mirror 350 suitably supported under the floor of the vehicle cab which can be viewed through a hole 351 in the cab floor. Steering guidance is effected through another inclined mirror 352 suitably mounted on a support 353 affixed to the front of the vehicle frame, this mirror enabling the operator to observe the position of a pointer 354 fixed to the vehicle frame 32 which will be aligned with the rotating cutter 28. By maintaining the pointer 354 along a desired line of movement over the highway, assurance is had that the cutter will follow the same line of movement. Another pointer 355 at the forward part of the vehicle, which can also be viewed by the operator from the inclined mirror 352, is attached to a suitable support 356 affixed to the front wheel steering linkage. By noting the relative positions of the two pointers 354, 355, the operator can steer the vehicle as desired for the purpose of controlling the position of the cutter 28 on the pavement.

During the operation of the cutter 28 on the pavement, flushing water is being discharged from the nozzles 303, and the mixture of the water, cuttings and air is being sucked through the pick-up tubes 304 and through the suction line 305 into the separator tank 306, the suction being maintained by rotation of the positive displacement vacuum pump 307, which removes the air from the separating tank. The slurry pump 311 removes the slurry and discharges it into the tank compartment 316 mounted on the vehicle trailer 313. As noted above, the water supply is also carried in the forward end rear compartments 315, 317 of the tank.

In the event it is desired to move the vehicle forwardly at substantially higher speed than can be effected through the low speed gear reduction box 219, with rotation of the cutter 28 continuing, the cutter 28 and roller 29 are elevated, the clutch 226 is disengaged and the other clutch 239 engaged so that driving of the vehicle then takes place through the high speed forward and reverse gear box 235, the desired forward speed being selected through manipulation of the shift levers 242. If reverse movement of the vehicle is

desired, the transmission 235 is placed in reverse gear, whereupon the clutch 239 is engaged, such reverse action occurring with the cutter 28 elevated and disengaged from the pavement.

In the event it is desired to move the vehicle to a relatively remote location, the cutter 28 and equalizing roller 29 are disengaged from the pavement. The axle clutches 25 are disengaged, which places the front wheels 12 in a free wheeling condition. The main clutch 200 leading from the grooving engine 26 is unclutched, which permits the vehicle to be operated by the normal vehicle engine 16 through its clutch 18a and transmission 18 to drive the rear wheels 14 and effect operation of the vehicle over the road in its normal manner. Such vehicle operation can take place at usual highway speeds, which may range from 30 to 70 miles per hour; whereas, the speeds for performing the grooving operation in the concrete, asphalt, or other pavement, would take place at a forward vehicle speed of from about 5 to 20 feet per minute. Because of the ability to move the equipment between job locations at a relatively rapid speed, it is unnecessary to furnish auxiliary equipment, such as tilt bed tractor-trailers for conveying the apparatus between locations.

In addition to the foregoing, it is to be noted that all of the auxiliary equipment, which is not mounted on the vehicle itself, is carried in the trailer 313 pulled by the vehicle. Thus, a single operator can perform all required functions with the apparatus, including the grooving of the pavement surface, the cleaning and flushing of the cuttings from the work area, the vacuuming of the cuttings and their discharge into the tank 315-317, and the withdrawal of water from the trailer mounted tank back to the nozzles 303. Movement of the vehicle through the front wheel drive mechanisms at higher forward speeds and in reverse can also be effected by the same single operator with the cutter 28 disengaged from the pavement surface. Accordingly, a substantial saving of labor cost is effected since one operator can perform all necessary operations. This is to be distinguished from other apparatus in which an operator of the grooving machine is required, as well as a helper, and a driver for a separate tanker.

We claim:

1. An apparatus for cutting roadway surfaces: a vehicle having a chassis, roadway engaging wheels for moving said vehicle longitudinally along the roadway, a first prime mover and first transmission means interconnecting said prime mover and at least some of said wheels for moving the vehicle over the roadway surface; cutter means supported by said chassis for cutting the roadway surface; means for rotating said cutter means to cut the roadway surface; second prime mover and second transmission means interconnecting said second prime mover and at least one of said wheels for moving the vehicle over the roadway surface at a substantially slower speed than said first prime mover and first transmission means during engagement of said cutter means with the roadway surface, said second prime mover and second transmission means being carried by said chassis.

2. An apparatus as defined in claim 1; said means for rotating said cutter means including said second prime mover.

3. An apparatus as defined in claim 1; and means for selectively rendering said first prime mover and first transmission means inoperative when said second prime mover and second transmission means are operative to move the vehicle over the roadway surface, and to render said second prime mover and second transmission means inoperative when said first prime mover and first transmission means are operative to move the vehicle over the roadway surface.

4. An apparatus as defined in claim 1; said first prime mover and first transmission means being operatively connectible to rear roadway engaging wheels; said second prime mover and second transmission means being operatively connectible to steerable front roadway engaging wheels.

5. An apparatus as defined in claim 1; means for selectively raising and lowering said cutter means from and into engagement with the roadway surface; said second transmission means including transmission ratio change means to enable the vehicle to be moved over the roadway surface at a faster speed with the cutter means disengaged from the roadway surface than when the cutter means is engaged with the roadway surface.

6. An apparatus as defined in claim 1; means for selectively raising and lowering said cutter means from and into engagement with the roadway surface; said second transmission means including forward and reverse gear means to enable the vehicle to be moved forwardly over the roadway surface with the cutter means engaged with the roadway surface and in reverse over the roadway surface with the cutter means disengaged from the roadway surface.

7. An apparatus as defined in claim 1; means for selectively raising and lowering said cutter means from and into engagement with the roadway surface; said second transmission means including transmission ratio change means to enable the vehicle to be moved forwardly over the roadway surface with the cutter means engaged with the roadway surface; said second transmission means further including a reverse gear to enable the vehicle to be moved reversely over the roadway surface with the cutter means disengaged from the roadway surface.

8. An apparatus as defined in claim 1; means for selectively raising and lowering said cutter means from and into engagement with the roadway surface; said second transmission means including transmission ratio change means to enable the vehicle to be moved over the roadway surface at a faster speed with the cutter means disengaged from the roadway surface than when the cutter means is engaged with the roadway surface; said first prime mover and first transmission means being operatively connectible to rear roadway engaging wheels; said second prime mover and second transmission means being operatively connectible to steerable front roadway engaging wheels.

9. An apparatus as defined in claim 1; means for selectively raising and lowering said cutter means from and into engagement with the roadway surface; said second transmission means including forward and reverse gear means to enable the vehicle to be moved forwardly over the roadway surface with the cutter means engaged with the roadway surface and in reverse over the roadway surface with the cutter means disengaged from the roadway surface; said first prime mover

and first transmission means being operatively connectible to rear roadway engaging wheels; said second prime mover and second transmission means being operatively connectible to steerable front roadway engaging wheels.

10. An apparatus as defined in claim 1; means for selectively raising and lowering said cutter means from and into engagement with the roadway surface; said second transmission means including transmission ratio change means to enable the vehicle to be moved forwardly over the roadway surface with the cutter means engaged with the roadway surface; said second transmission means further including a reverse gear to enable the vehicle to be moved reversely over the roadway surface with the cutter means disengaged from the roadway surface; said first prime mover and first transmission means being operatively connectible to rear roadway engaging wheels; said second prime mover and second transmission means being operatively connectible to steerable front roadway engaging wheels.

11. An apparatus as defined in claim 1; means for selectively raising and lowering said cutter means from and into engagement with the roadway surface; said second transmission means including transmission ratio change means to enable the vehicle to be moved forwardly over the roadway surface with the cutter means engaged with the roadway surface; said second transmission means further including a reverse gear to enable the vehicle to be moved reversely over the roadway surface with the cutter means disengaged from the roadway surface; said first prime mover and first transmission means being operatively connectible to rear roadway engaging wheels; said second prime mover and second transmission means being operatively connectible to steerable front roadway engaging wheels; and means for selectively rendering said first prime mover and first transmission means inoperative when said second prime mover and second transmission means are operative to move the vehicle over the roadway surface, and to render said second prime mover and second transmission means inoperative when said first prime mover and first transmission means are operative to move the vehicle over the roadway surface.

12. An apparatus as defined in claim 1; said cutter means being located entirely at one side of the vehicle; and an equalizing means at the other side of the vehicle supported by the chassis and engageable with the roadway surface to prevent said cutter means from tilting said chassis when engaged with the roadway surface.

13. An apparatus as defined in claim 1; said cutter means being located entirely at one side of the vehicle; and an equalizing means at the other side of the vehicle supported by the chassis and engageable with the roadway surface to prevent said cutter means from tilting said chassis when engaged with the roadway surface; and means for raising and lowering said cutter means and equalizing means from and into engagement with the roadway surface.

14. An apparatus as defined in claim 1; means for selectively raising and lowering said cutter means from and into engagement with the roadway surface; said second transmission means including transmission ratio change means to enable the vehicle to be moved over the roadway surface at a faster speed with the cutter

means disengaged from the roadway surface than when the cutter means is engaged with the roadway surface; said cutter means being located entirely at one side of the vehicle; equalizing means at the other side of the vehicle supported by the chassis and engageable with the roadway surface to prevent said cutter means from tilting said chassis when engaged with the roadway surface; and means for raising and lowering said equalizing means from and into engagement with the roadway surface.

15. An apparatus as defined in claim 1; means for selectively raising and lowering said cutter means from and into engagement with the roadway surface; said second transmission means including transmission ratio change means to enable the vehicle to be moved forwardly over the roadway surface with the cutter means engaged with the roadway surface; said second transmission means further including a reverse gear to enable the vehicle to be moved reversely over the roadway surface with the cutter means disengaged from the roadway surface; said cutter means being located entirely at one side of the vehicle; equalizing means at the other side of the vehicle supported by the chassis and engageable with the roadway surface to prevent said cutter means from tilting said chassis when engaged with the roadway surface; and means for raising and lowering said equalizing means from and into engagement with the roadway surface.

16. An apparatus as defined in claim 1; means for selectively raising and lowering said cutter means from and into engagement with the roadway surface; said second transmission means including transmission ratio change means to enable the vehicle to be moved forwardly over the roadway surface with the cutter means engaged with the roadway surface; said second transmission means further including a reverse gear to enable the vehicle to be moved reversely over the roadway surface with the cutter means disengaged from the roadway surface; said first prime mover and first transmission means being operatively connectible to rear roadway engaging wheels; said second prime mover and second transmission means being operatively connectible to steerable front roadway engaging wheels; and means for selectively rendering said first prime mover and first transmission means inoperative when said second prime mover and second transmission means are operative to move the vehicle over the roadway surface, and to render said second prime mover and second transmission means inoperative when said first prime mover and first transmission means are operative to move the vehicle over the roadway surface; said cutter means being located entirely at one side of the vehicle; and equalizing means at the other side of the vehicle supported by the chassis and engageable with the roadway surface to prevent said cutter means from tilting said chassis when engaged with the roadway surface; and means for raising and lowering said equalizing means from and into engagement with the roadway surface.

17. An apparatus for cutting roadway surfaces: a vehicle movable over the roadway surface; a cutter for cutting the roadway surface; means for supporting said cutter from the vehicle for engagement with the roadway surface entirely at one side of the vehicle; an equalizer member; means for supporting said equalizer

member from the vehicle for engagement with the roadway surface at the opposite side of the vehicle to resist tilt of the vehicle by said cutter when engaged with the roadway surface; means for moving said cutter and equalizing member into and from engagement with the roadway surface; and means for rotating said cutter for cutting into the roadway surface as the vehicle moves therealong.

18. An apparatus as defined in claim 17; said cutter supporting means comprising an arm pivotally supported on the vehicle at its upper end with the cutter rotatably mounted on the lower end of the arm; said equalizer member supporting means comprising an arm pivotally supported on the vehicle at its upper end with the equalizer member mounted on the lower end of said arm; said means for moving said cutter and equalizer member comprising means connected to said arms to raise and lower said arms about their pivotal supports on the vehicle.

19. An apparatus as defined in claim 17; said cutter supporting means comprising an arm pivotally supported on the vehicle at its upper end with the cutter rotatably mounted on the lower end of the arm; said equalizer member supporting means comprising an arm pivotally supported on the vehicle at its upper end with the equalizer member mounted on the lower end of said arm; said means for moving said cutter and equalizer member comprising cylinder means for each arm, piston means for each arm in said cylinder means, and linkage means for each arm connected to said arm, piston means and vehicle for swinging each arm about its pivotal support in response to the feeding of fluid under pressure into said cylinder means to effect engagement and disengagement of said cutter and equalizer member with respect to the roadway surface.

20. An apparatus as defined in claim 17; said equalizer member comprising a wheel rotatably mounted on said equalizer member supporting means for rotation about an axis parallel to the axis of rotation of said cutter.

21. An apparatus as defined in claim 17; said equalizer member comprising a wheel rotatably mounted on said equalizer member supporting means for rotation about an axis parallel to the axis of rotation of said cutter; said cutter supporting means comprising an arm pivotally supported on the vehicle at its upper end with the cutter rotatably mounted on the lower end of said arm; said equalizer member supporting means comprising an arm pivotally supported on the vehicle at its upper end and with the wheel rotatably mounted on the lower end of said arm; said means for moving said cutter and equalizing member comprising means connected to said arms to raise and lower said arms about their pivotal supports on the vehicle.

22. An apparatus as defined in claim 17; said equalizer member comprising a wheel rotatably mounted on said equalizer member supporting means for rotation about an axis parallel to the axis of rotation of said cutter; said cutter supporting means comprising an arm pivotally supported on the vehicle at its upper end with the cutter rotatably mounted on the lower end of said arm; said equalizer member supporting means comprising an arm pivotally supported on the vehicle at its upper end and with the wheel rotatably mounted on the lower end of said arm; said means for moving said

cutter and equalizing member comprising cylinder means for each arm, piston means for each arm in said cylinder means, and linkage means for each arm connected to said arm, piston means and vehicle for swinging each arm about its pivotal support in response to the feeding of fluid under pressure into said cylinder means to effect engagement and disengagement of said cutter and wheel with respect to the roadway surface.

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